Guideme: An Optimized Mobile Learning Model Based on Cloud Offloading Computation

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Abstract. There is growing interest in using mobile learning systems to improve connection between various partners in educational institutions. With Mobile learning, there are variety of users, services, education contents and resources; in any case, how to deploy M-learning applications is quite a challenging demand. On the other hand, the addressed success of cloud computing as a large scale economic paradigm with virtualization appeared to resolve issues as storage capacity, resource pooling, elasticity and offloading. This research gained benefits from cloud computing resources and capabilities in proposing effective mobile learning model. We specifically address a case study for students and their learners applied on Egyptian schools. Guideme is implemented based on android platform with support of text and content offloading facilities. Furthermore, we investigate the performance of proposed model , we concludes that Guidme model can optimize responsivity by leveraging public cloud server about 1.7% for light computation offloading, and 11% while intensive computation offloading.

Keywords: mobile learning; cloud computing; offloading computation; response time

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1 Introduction

These days e-learning broadly use by instructive foundations while supporting their learning procedure and give whenever administration to students to access learning material and data. The usage of e-learning has been executed by a few instructive establishments in Egypt [1].

As Egyptian society turns out to be progressively reliant on innovation, schools are putting more effort in technological means for communication. Access to PC and Internet advances is extending all over world. In work places, schools and homes for both two teachers and guardians are provided with access to electronic communication to access learning material and data.

Meanwhile, at these days Cell phones or Smartphones are broadly utilized and give extraordinary correspondence and multimedia capabilities, which make the conveyance of learning exercises and out of class cooperation a progressively practical methoolgy[2].Eventhough, Elearning affords many benefits including flexibility, vari ety, mobility, and others. Still one reason for the lack of cell phone use in communicating with educational institutions could be the trust on performance [3].

On the other side, unreliable infrastructure turns into a noteworthy issue while implementing m-learning. Institutions need to execute m-learning troubles in the obtainment of server/PC, storage, and stable networks [4]. That's beside issues related to professional skills, not the majority of the organizations have the expert staff for planning, creating such apps to oversee e-learning, However, with the improvement of the IT world, distributed computing is progressively turned into the new worldview of innovation in the IT world, hence cloud computing features with resource pooling. The provider's computing resources are pooled to serve more clients using a multitenant paradigm, with variant virtual and physical resources which powerfully relegated and reassigned by customer request.

Therefore, cloud computing come to save server time and network storage, as needed automatically without requiring human capacity and communication for aiding service from provider and stakeholders. Currently, set of works and research in CC are working to enhance computing capabilities to benefit constrained cellular phones by means of full access to cloud infrastructures, software, and computing services.

Consequently, Cloud processing offers a great option of offloading processing for large tasks requiring more time for calculation. One popular technique of cloud computing is offloading[4]. Computation offloading helps in improving mobile application performance, reduce its power consumption and accelerate respositivity [5]. Offloading, also referred as remote execution, is to make some computation intensive code of an application performed on a remote server, in order that the utility can take benefit of the powerful hardware and the sufficient power supply for increasing its responsiveness and reducing its battery power intake[6],

While Offloading, accomplish genuinely computation augmentation for constrained cell phone, the Performance of application execution still needs to be monitored.

In this paper, we will discuss previous studies focusing on m-learning models based on any of mobility pervasive computing, The review of others researches demonstrates that recent related ones cover limited subsets of computing offloading and its impact on reducing response time at some circumstances. At this manner we will propose a novel of new m-leaning model based on mobile services can benefit in offloading while immigrating intensive tasks in fly. Proposed model depends on public cloud and conventional client/server model depending on network condition.
We investigate efficiency of two provided modes in term of responsivity.

Evaluation of prototype efficiency exposed improving which migrating to public cloud on most cases. Rest of this paper is organized as following: Section 2 presents an overview of m-learning models, While section 3 addresses the proposed model called "Guidme" and its components. Section 4,details model Implementation steps, Evaluation of prototype efficiency will be focused on in section 5. In conclusion, Section 6 finishes up the paper and draws new future work thoughts.

2 Related Works

For supporting m-learning , many models raised for executing cloud based mobile applications. For instance,

Rogers [7] study examined correspondences innovations in encouraging parental association in middle schools and uncovers barriers that prevent usage of technology to promote communication. Study reason for existing was to evaluate the job of two relational interchanges technologies, telephone and e-mail, one popular communication technology; school websites, in the communication practices between middle school students' parents/guardians and instructors

The outcomes demonstrate that numerous parents still depend on customary types of communication including landline telephones, printed pamphlets, and eye to eye communication, which uncovers that teachers and guardians alike are not exploiting the advantage of the convenience and quickness of communicating through electronic methods like e-mail and websites.

After deep analysis, it has been noticed that none of the above models considering performance parameters with high impact on user satisfaction. Service response time appears to be highest factors affecting on satisfaction, specially while post and request heavy tasks consuming a lot from device capabilities and therefore user time. That's influence us towards constructing a new novel focusing on responsivity can satisfy client requests and needs, enhance device performance.

From mobile service point of view, our "Guideme" model offers new solution to enhance performance of mobile learning models in a novel not focused in before.

2.1 Cloud Computing

Researchers defined cloud computing as:

Information technology service paradigm where computing services both software and hardware is delivered on demand to clients over a network in a self-service style, independent of location or device characteristics as in illustrated in fig1. The re-

sources required to provide the requisite quality-of service levels which are shared, quickly provisioned, progressively scalable, virtualized and discharged with minimal service provider interaction. Clients pay for the service as a working cost without acquiring any noteworthy introductory capital use[8].

Our research will utilize Microsoft azure as public cloud provider benefits from "as you go" model for cost customization.

On the other side, a conventional desktop server should be utilized as on- premise server acting acting as switching mode in case of failure circumstances or network delay.

2.2 Offloading computation

Computation offloading is process of sending computation intensive application components to a remote server [9]. As of late, several of computations offloading systems have been proposed with a few methodologies for applications on cell phones. These applications are apportioned at various granularity levels, parts are sent (offloaded) to remote servers for remote execution in order to extend and enhance cell phone capabilities [9-11]more about offloading techniques illustrated in Fig[2].

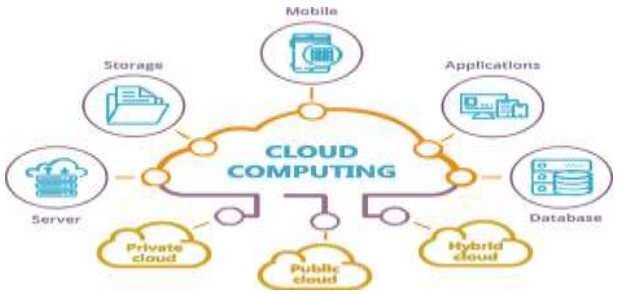


Fig. 1. Cloud Computing Architecture

3 Proposed Model Architecture

Fig3. Illustrate the basic architecture of the proposed m-learning service model; Guidme is mostly offloading concept dependent on which discussed in section2, two important concepts, first one is public cloud computing and second one is nearby desktop server through access protocols, both of them cell phones must be connected to network using wireless connection like WiFi or 4G cellular radio. Guidme has two basic models; first model is developed as client native side, instantiate as interface app for student, installed and configured at their android phones. using this app, Students can upload photos to their learners' for any diary content asking for confirmation or help, parents can easily contact learners' in case of inconvenience for any matter related to their child progress. At client side, Offloading service module dynamically select the appropriate offloading resources whether is public cloud or desk-

top nearby server in case of disconnection condition, However, adaptation on offloading is always required, decision will be taken at runtime whether mobile codes should be offloaded and which parts ought to be executed remotely . For example, if the remote open server ends up inaccessible because of unstable network connection, operated tasks should be rendered to the device, otherwise go to execute at another available server as registered.

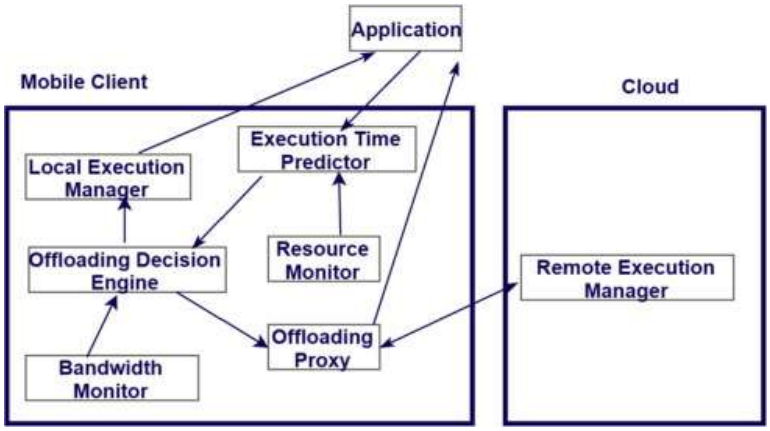


Fig. 2. Mobile offloading procedure

Remote Server is constantly receives the request from multiple cell phones, server creates multiple clones to handle the multiple request from the client.

Each cloud clone is now responsible to handle the request from the mobile client and clone stores and retrieves the "guideme" content and text inquiry.

On the other side, Learner can receive content and text messages using GUI interface, Fig4. Illustrate guideme model UseCase.

Additionally, a monitoring algorithm has been constructed for detection task, quality of network connections, delay calculation, server status are managed throughout decision making engine module.

4 Implementation

The proposed model is divided into two parts, client part consists of set of services ,one for offloading images as in part 4.1 , another service for offloading text from parent as in part 4.2, the offloading module service includes decision making engine at part 4.3,client part deployed and configured at client cell phones, the client side has been developed using software known as android studio, application development, based on IntelliJ IDEA which known as integrated development environment (IDE)

This IDE contains a base workspace and extensible plug-in system for customizing the environment written mostly in Java, The IDE[12,13] can be integrated with data-

base engine, Google Cloud Messaging and App Engine, following sections present brief listings of some major modules.

4.1 Content Service Module

Content service is a main feature of this model. Camera capabilities were mostly used to snap pictures and tag them.

Camera app is one of the most popular applications for mobile devices which makes heavy use of the camera hardware. Instagram and Snapchat are two examples that implement their own custom camera view instead of using the built in application that comes with the mobile device.

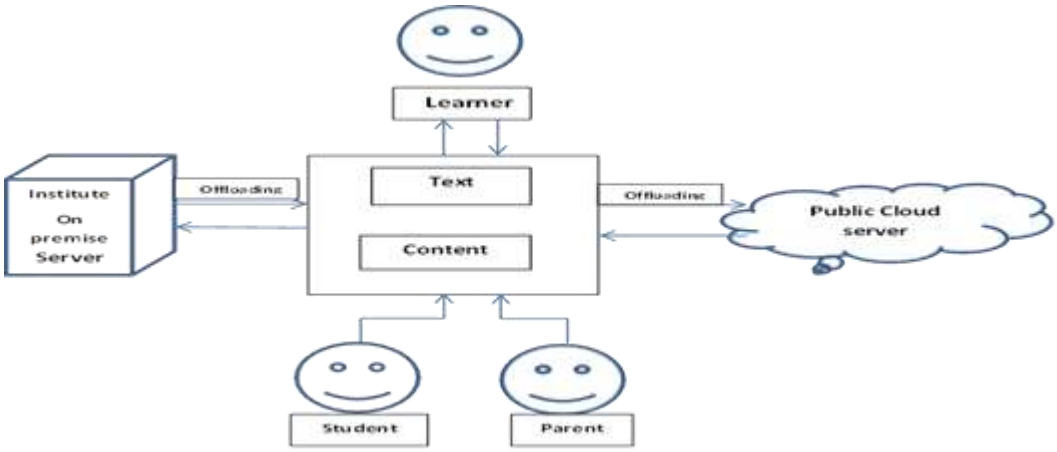


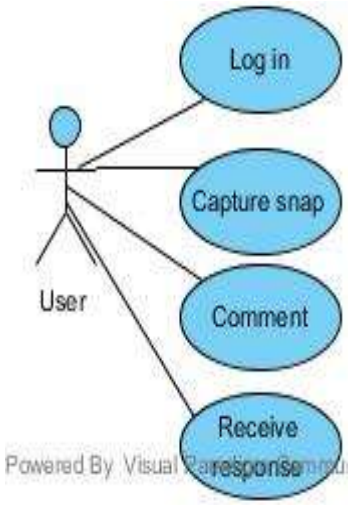
Fig. 3. Guideme Architecture

To access camera features, permission should set in the Android Manifest file, that's achieved by including the <uses-permission> as CAMERA and other manifest element <uses features> to declare camera features used by the application.

To set image capture settings, Camera class is used, with methods of start or stop preview and snap pictures. This class manages the actual camera hardware for the Camera service. The standard intent ACTION_IMAGE_CAPTURE is used by the camera application to capture an image and return it back. To store images captured inside gallery and entitled them, EXTRA_OUTPUT parameter is set as well. Finally, Application stores the images inside cloud server in time client can view it within Image Gallery of the phone, Fig.5 presents as a sample sequence diagram of content service module.

4.2 Texting Service Module

In order to contact with learner, a Complain class has been created instantiate On-create() method, an instance of onclicklistener instantiate to handle http get() and post() methods for binding student name ,email address, department name, phone



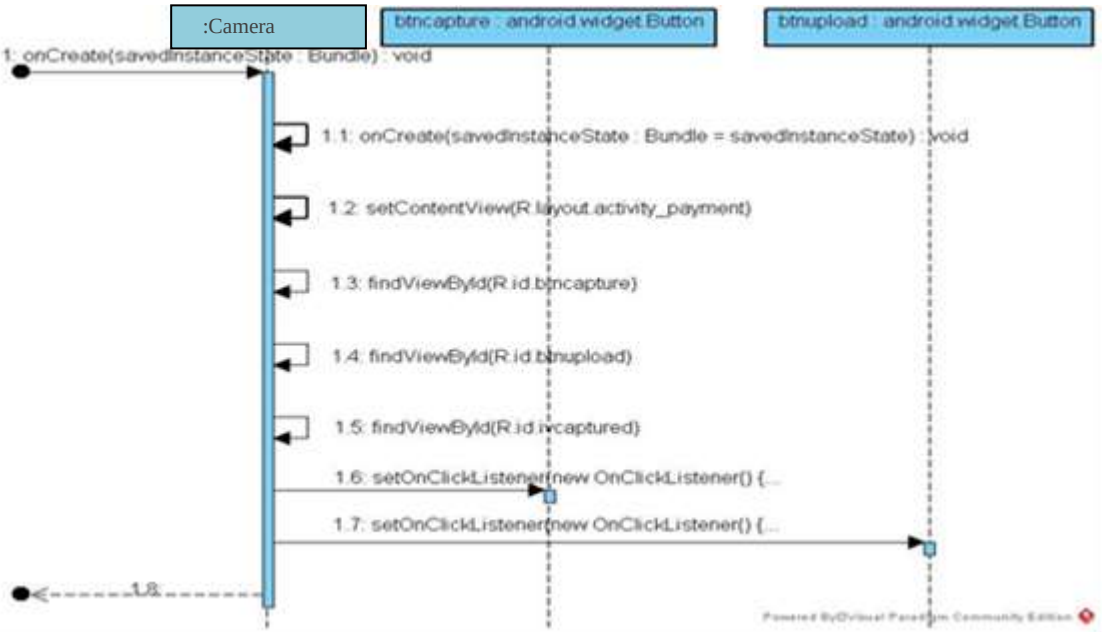


Fig. 4. Guidme Usecase

Fig. 5. Sequence Diagram of Content Service Activity

number parameters, Both aforementioned services utilize azure SQL database to migrate data to its portal with synchronization to SQL server database engine[14].

4.3 Offloading Service Module

Offloading module consists of several components, including network status monitor, an offloading decision engine, a resource monitor, and an offloading proxy can connect offloading remote execution manager to decision engine. The decision engine constructed in order to investigate delay due to offloading. Before execution, two types of comparisons are made (1): The average response time of the application running on the public cloud server comparing to time consumed if offloading done to on premise server and after detecting network conditions.

There are two decisions regarding selecting appropriate offloading modes:

Condition 1: there is good network connection to cloud where

$$T_{public} = T_{net} + T_{cloud} \quad (1)$$

Condition2: there is good network connection to on premise server where

$$T_{server} = T_{net} + T_{on\text{-}premise} \quad (2)$$

Offloading to public cloud is beneficial in case of $T_{public} < T_{server}$

5 Evaluation

In order to characterize the advantages of using our Model, we carried out set of experiments and studied the impact of the proposed Model in term of responsivity [15] on applied Services. From this perspective our experiments goal are twofold, first:

1)To validate whether our model is feasible to offload real implemented tasks using different types of android devices; second: to compare the performance of of-

floaded tasks to public cloud comparing to offloading same tasks to on-premise server in term of response time. To achieve first goal, a suite of micro-benchmark was conducted.Our benchmark took place on Samsung and HTC devices respectively, both of them have been charged totally, and after that we kill all background tasks appeared in multitasking menu. We don't need anything to interfere with our tests, so additionally we placed them in Airplane mode to keep them from bringing mail or accepting calls.

Our benchmarking test consisted of a client installed on aforementioned cell phones and a server application running on the cloud azure and SQL server engine.

Using 11 real benchmarks, we gather and then analysis tasks execution among trips. The evaluation results are validated via statistical modeling as in table I.

Table 1. I Evaluation Benchmark Recorded Values

Device	System Function	Cloud server response time	Median	Standard deviation	On premise server response time
galaxy J7 prime	Text offloading	2.46	2.5	0.332483766	2.5
	Content offloading	4.36	4.4	0.492612085	5.1
HTC Desire816G	Text offloading	2.41	2.45	0.260128174	2.3
	Content offloading	5.75	5.65	0.634647759	6

2)To achieve second goal, and to conduct responsivity in our experiment, we measured the total response time as demonstrated at equation (1),(2), experiments executed 11 times among different intervals to show actual result using stable WiFi connection.

At these experiments, we monitored execution time for each service standalone, first we exploit automatic timer to begin directly before sending the solicitation and to stop directly in the wake of getting the response in on premise server mode , then we record azure public cloud metrics and dashboard where it offers helpful performance monitoring layout as in Fig 6.

During experiments, It's noticed that device capabilities may affect responsivity. Precisely, processing power of devices may affect overall performance and that's appear while comparing in our benchmark between Samsung and HTC, as in Fig7.

Additionally, we observed that service computation complexity has its' influence on offloading significantly. We found that while requesting and posting text of-

floading service, it consumes about 2.4 seconds, while invoking content service and post captured image from public server, it takes average 4.3 seconds, in time it consumes average 4.7 in case of on- premise server as illustrated in Fig8.

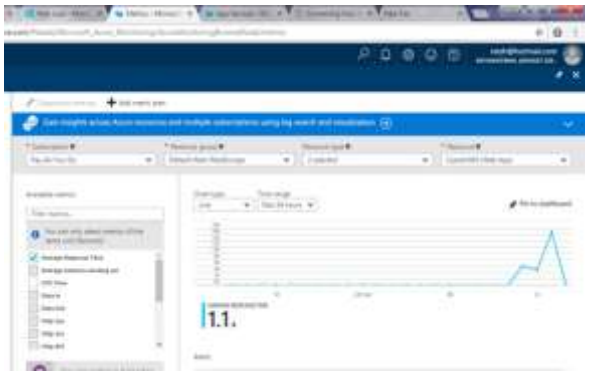


Fig. 6. Cloud Response Time Metrics

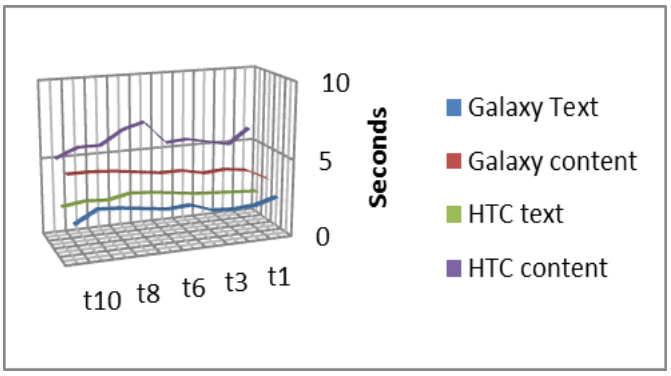
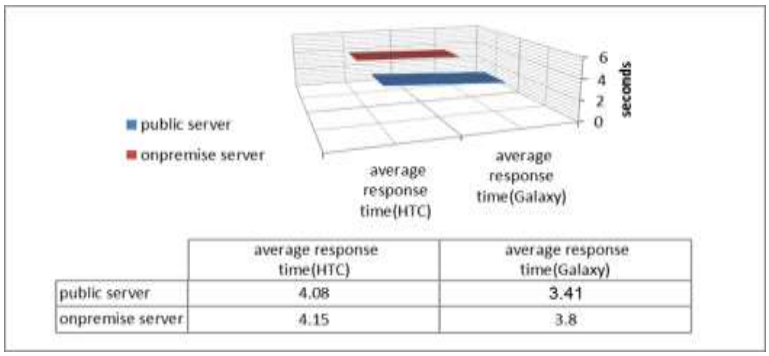


Fig. 7. Guidme Performance Benchmark

6 Conclusion and Future Works

In this paper, an effective mobile learning model was presented, we specifically address a case study for students and their learners applied on Egyptian schools. Guideme is implemented based on android platform with support of content and text offloading facilities, one of them is public cloud computing and other one is nearby desktop server, Offloading dynamically select the appropriate resources, decision is taken at runtime according to adaptation condition. Furthermore, we investigate the performance of proposed model which concludes efficiency in term of response time, using public cloud optimize provided services performance, emphasize robustness and availability demands.

Future works may conduct more experiments on other real mobile device with other features and characteristics. More conditions and rules should be applied in the offloading decision model in order to achieve better results.



	average response time(HTC)	average response time(Galaxy)
public server	4.08	3.41
onpremise server	4.15	3.8

Fig. 8. Guidme performance evaluation optimization

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